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Evaluation of a Method to Determine Spruce-Fir Mortality Caused by Spruce Budworm in the Lake States, 1979

During the summer of 1979, selected stands were examined for five, risk, and dead spruce and balsam fir. A center point plus four satellite points were established as a temporary plot in each stand. The satellite points, at cardinal directions, were 2 chains (40 m) from the center point. A 10-mesh-transect prism was used at each point to determine the number of balsam fir and spruce to be recorded by basal area estimator. One five and one dead balsam fir and one five and one dead spruce nearest each point were measured to obtain dbh and the number of merchantable 8-ft (2.44 m) sticks to a 4-in (10.2 cm) diameter top. Defoliation estimates were recorded for spruce and fir at each point.

By the summer of 1979, two stands were randomly selected for sampling from a list of 617 merchantable spruce-fir stands on the Chippewa, Superior, Chequamegon, and Isle Royale National Forests in Minnesota and Wisconsin. Merchantable stands were defined as having at least a cord/acre (4.87 m³/ha) of merchantable white spruce and/or balsam fir, accessible for harvesting, and in designated multiple-use areas. The Minnesota Department of Natural Resources, using the same criteria for stand selection, selected 16 stands on State land and 10 on private land.

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EVALUATION OF A METHOD TO DETERMINE SPRUCE-FIR MORTALITY
CAUSED BY SPRUCE BUDWORM IN THE LAKE STATES, 1979

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INTRODUCTION

There is a need to develop and evaluate methods of measuring mortality of merchantable timber resulting from uncontrolled defoliation by the spruce budworm (Choristoneura fumiferana (Clemens)). Spruce budworm outbreaks in spruce and fir stands nationwide, including the Lake States of Michigan, Minnesota, and Wisconsin, disrupt management plans and cause concern about timber losses. A method that might efficiently determine spruce-fir losses was evaluated in 1979. This report describes that method, which was based on random selection of plots, and recommends ways to improve it.

OBJECTIVE

The objective was to design, use, and evaluate a method of estimating the volume of merchantable spruce and fir recently killed by the spruce budworm.

The criteria for the evaluation were:

1. Precision of ± 20 percent of the mean volume of killed spruce and fir, one standard deviation.
2. A survey method that could be accomplished in 10 person-months in the Lake States.

METHODS

One hundred forty-two stands were randomly selected for sampling from a list of all merchantable spruce-fir stands on the Chippewa, Superior, Chequamegon and Nicolet National Forests in Minnesota and Wisconsin. Merchantable stands were defined as having at least 5 cords/acre ($4.87 \text{ m}^3/\text{ha}$) of merchantable white spruce and/or balsam fir, accessible for harvesting, and in designated multiple-use areas. The Minnesota Department of Natural Resources, using the same criteria for stand selection, selected 16 stands on State land and 10 on private land.

During the summer of 1979, selected stands were examined for live, risk, and dead spruce and balsam fir. A center point plus four satellite points were established as a temporary plot in each stand. The satellite points, at cardinal directions, were 2 chains (40 m) from the center point. A 10-basal-area-factor prism was used at each point to determine the number of balsam fir and spruce to be recorded by basal area categories. One live and one dead balsam fir and one live and one dead white spruce nearest each point were measured to obtain dbh and the number of merchantable 8-ft (2.44 m) sticks to a 4-in (10.2 cm) diameter top. Defoliation estimates were recorded for spruce and fir at each point.

The data were analyzed to determine the average number of cords per acre of live, dead, and risk spruce and fir. These values were converted to metric units at 85 ft^3 (2.4 m^3) per cord. The percent error of each average and the approximate number of plots needed to meet the precision level in the evaluation criteria were calculated. Data were sorted and analyzed according to ownership (Federal, State, or private) and state (Minnesota and Wisconsin).

RESULTS

The average stand sampled contained $10.2 (\pm 4 \text{ percent})$ cords/acre ($9.9 (\pm 4 \text{ percent}) \text{ m}^3/\text{ha}$) of white spruce and balsam fir. Of this volume, $0.43 (\pm 22 \text{ percent})$ cords/acre ($0.42 (\pm 22 \text{ percent}) \text{ m}^3/\text{ha}$) had been killed by spruce budworm defoliation. Most of this dead volume (0.41 cords/acre or $0.4 \text{ m}^3/\text{ha}$) was balsam fir. About 0.5 cord/acre ($0.5 \text{ m}^3/\text{ha}$) of all balsam fir was at risk, which means it will die in a year or two.

There was a greater volume per unit area of spruce and fir in Wisconsin than in Minnesota, but the proportion of spruce to fir was about the same -- one cord/acre ($0.97 \text{ m}^3/\text{ha}$) of spruce for every 5.5 cords/acre ($5.4 \text{ m}^3/\text{ha}$) of balsam fir. In Minnesota one of every 20 cords (48 m^3) of spruce and fir was dead, while in Wisconsin one in 32 (77) was dead. Ten percent of Wisconsin's spruce-fir volume was at risk because spruce budworm populations had been high for the previous 3 years. In Minnesota, however, where budworm populations were low, only 2 percent of the spruce-fir volume was at risk.

A summary of volume lost and area infested by spruce budworm according to ownership and state is shown in Table 1.

All Wisconsin stands sampled were somewhat defoliated by spruce budworm. Nearly 25 percent of the spruce-fir type was severely defoliated, while 15 percent was lightly defoliated. In Minnesota, however, less than 25 percent of spruce-fir type suffered moderate to severe defoliation and 12 percent of the stands were uninfected.

Four temporary forest technicians for the St. Paul Field Office needed 8 person-months to complete the survey on four National Forests; and four Minnesota DNR pest managers each took 2 weeks to do the survey on State and private lands.

CONCLUSIONS

This survey failed to meet the required precision limits of 20 percent of the mean volume per unit area of dead spruce and fir, one standard deviation. Much effort went into surveying healthy stands, indicating that some sort of stratification is needed in future surveys to include only stands with budworm-killed timber.

This survey took longer to complete on four National forests and in one state than the 10 person-months the criteria allow for a survey on six National Forests and three states.

Recent spruce budworm defoliation killed about 41 ft³/acre (0.47 m³/ha) of merchantable spruce-fir in Minnesota and Wisconsin.

RECOMMENDATION

Future spruce budworm loss assessment surveys should be done only after spruce-fir stands have been classified by presence or absence of timber killed by spruce budworm defoliation. Ground survey effort should be limited to the stands where a recent budworm outbreak has killed trees. Classification can be accomplished reasonably from aerial sketchmap surveys outlining areas of defoliation and dead spruce-fir. The probability of selecting any stand for sampling should be proportionate to its size. The number of sample plots should depend upon the variation in volume as well as in acres of dead timber and the allowable error. A plot of five prism points arranged in a fixed cluster should be used to sample stand tree condition.

The aerial sketchmap survey data could also be used for level 1 (area infested) information needed for Forest Insect and Disease Information System (FIDIS) reports.

Table 1.--Area infested and commercial value lost in 1979 to defoliation of spruce-fir by the spruce budworm

Ownership	Area infested		Volume loss ^{a/} 1978-9		Stumpage loss ^{b/}
	M acres	M ha	M ft ³	M m ³	M \$
MINNESOTA					
National Forest	87	35	2891	81.9	340
State	216	87	15,793	447.3	1858
Private	135	55	661	18.8	78
WISCONSIN					
National Forest	114	46	3287	93.1	386

^{a/}At 85 ft³/cord

^{b/}At \$10/cord (\$4.15/m³) stumpage